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Application of GPR-grid maps to sinkhole areas. A new methodological approach.

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The main drawback of GPR surveys when applied to alluvial sinkhole detection is usually the low penetration depth, related to high clay contents of soils. GPR survey interpretations are mainly related with the direct analysis of radargrams. Sometimes, in continuously subsident zones, small changes in the subsoil properties, related or not with a deep cavity, can be unnoticed in the surveys. In this work we present a new methodology, mainly related to the study of the changes of the amplitude of the waves in the subsoil, that can be used as very sensitive indicator of EM changes in the subsoil. In some cases, where the direct study of the profiles is not straightforward and high resolution surveys are done, these grid maps can be used to infer processes and locate hazard zones. In a homogenous soil, GPR waves show in-phase waves throughout the surveyed zone. Small changes in the EM properties of the subsoil will be observed as changes in the amplitude or changes in the phase of the wave. The qualitative study of correlation maps between different profiles, or even in the same profile, can permit the identification of the anomalous zone, and the mapping of the anomalous sector. The study of the profiles and the grid maps can permit the identification of anomalous EM wave behaviours related with geometrical features that can be linked to subsident processes. These changes in the waves can show echoes in the profiles, where a residual map - map obtained from a depth located below the maximum reached depth, or with an homogeneous behaviour- can show very straightforward the map of the anomalous zone. Positive anomalies in the grid maps can be related with higher qualitative penetration depths, lower attenuation or multiple reflection anomalies related with elements with very high conductivities. Negative anomalies in the grid maps are related with higher attenuation and lower qualitative penetration depths. In this work

we present several examples from the Central Ebro Basin, where positive anomalies are usually related with anthropogenic fillings of the subsident or collapsed zones, mainly associated with dump materials (with higher conductivity and thus producing multiple reflection anomalies, or lower conductivity and then generating lower attenuation). On the other hand, negative anomalies are mainly related with subsident zones with a natural filling that usually show higher clay contents (aeolian-fluvial deposits or anthropogenic filling consisting of agricultural soil).